Various dietary fat supplements modified simultaneously milk and muscle lipids in lactating cows

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INTRODUCTION

The lipid composition of animal derived foods can be affected by different factors as diet, breed, sex, growth, saison and age. Considering the fact that both, meat and milk, are subjected to human consumption, this study intended to characterise how dietary fatty acids are transferred into and accumulated in meat as well as milk of dairy cows.

ANIMAL EXPERIMENT

In total 18 German Holstein cows in their first lactation (92 days in milk) were included in a 10 weeks feeding experiment. The basal diet consisted of grass silage, maize silage, hay, concentrate, and mineral feed mixture. SAT group was supplemented with palm fat (3.1 % of the basal diet DM), LINA group with linseed oil (2.7 % DM) and algae rich in DHA (0.4 % DM), and SUNA group with sunflower oil (2.7 % DM) and algae rich in DHA (0.4 % DM) to the same basal ration conforming the total mixed ratio which was isoenergetic and isonitrogenous calculated.

METHODS

Fat was extracted from *longissimus* muscle (MLD) using chloroform/methanol (2:1) and from milk using *n*-hexane/isopropanol (3:2) by Ultra Turrax homogenization at room temperature. The fatty acid methyl esters have been prepared with Na-methoxide and followed by BF3/methanol [J. Angulo et al. (2012) J Sci Food Agric, 92, 2968-2974].

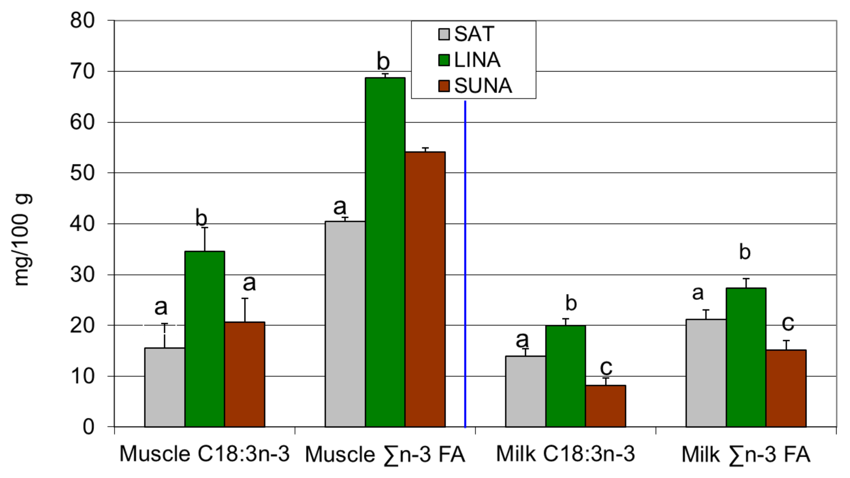

Figure 2a: Linolenic acid and the sum of *n*-3 FA (mg/100g) in MLD and milk

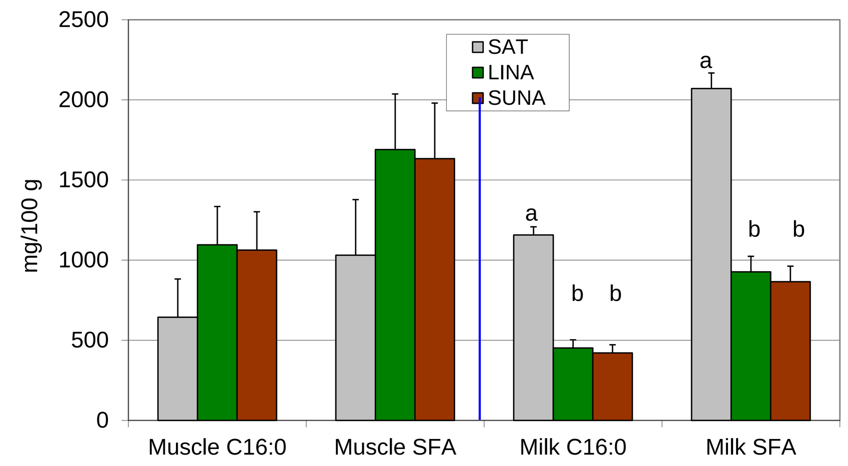

Figure 2b: Palmitic acid and SFA in MLD and milk

RESULTS

Exogenous *n*-3 fatty acid supply (LINA) caused significant higher concentration of C18:3*n*-3 (%) in milk and intramuscular fat. Exogenous *n*-6 FA supply (SUNA) only increased *n*-6 fatty acids (%) in milk. Feeding plant/algae PUFA to dairy cows decreased significantly the content of total saturated FA in milk. Contrary to this there was a tendency for a higher deposition of SFA in muscle fat. The percentage of C18:1*trans*-11 and the sum of the total C18:1*trans* isomers in muscle and milk were significant higher with plant oil/algae feeding. SUNA feeding caused a significant higher CLA*trans*-10,*cis*-12 and CLA*trans*-7,*cis*-9 percentage in both tissues.

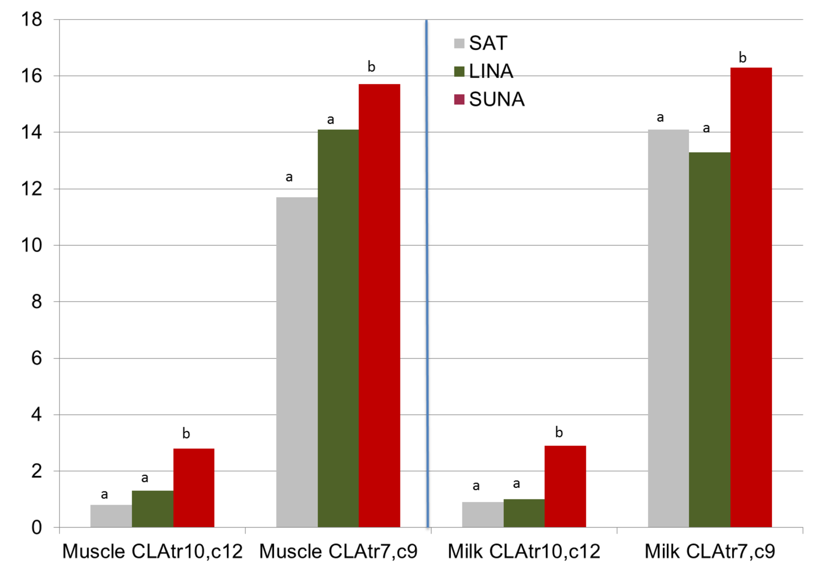

Figure 1a: CLAtr10,c12 and CLAtr7,c9 (%) in muscle and milk (HPLC)

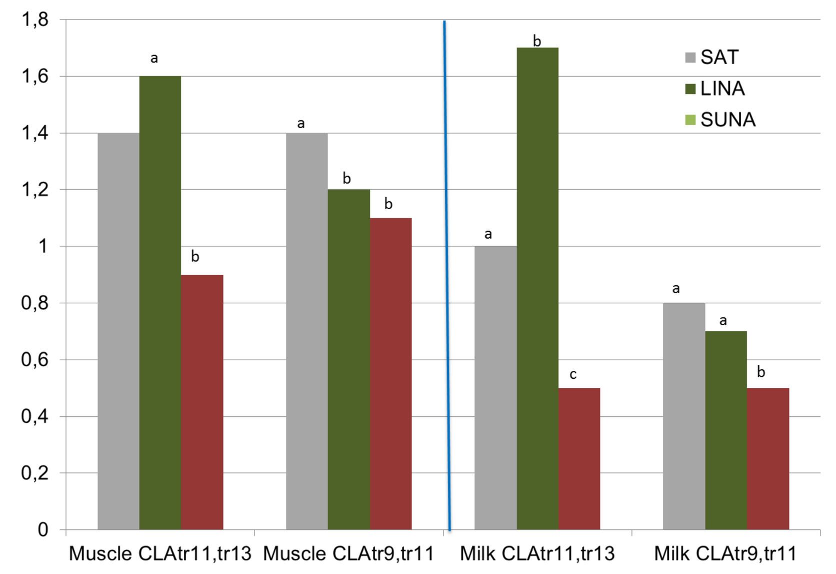

Figure 1b: CLAtr11,tr13 and CLAtr9,tr11 (%) in muscle and milk (HPLC)

Table 3: Muscle fatty acid composition (%) of cows fed different fat supplements

Fatty acids	SAT LSM	LINA LSM	SUNA LSM
Muscle fat	3.0	4.1	3.6
C12:0	0.05	0.07	0.07
C14:0	2.3	3.1	3.0
C16:0	27.6	29.6	31.4
C16:1	3.9	4.4	4.2
C18:0	14.3	12.3	12.7
Σ C18:1*trans*	1.1^{a}	2.8^{b}	3.5^{b}
C18:1*tr*-11	0.6^{a}	$1.1^{a,b}$	1.9^{b}
C18:1*cis*-9	35.9^{a}	$33.5^{a,b}$	29.9^{b}
C18:2*n*-6	3.7	2.5	3.4
C18:3*n*-3	0.8^{a}	1.0^{b}	0.6^{a}
C20:4*n*-6	1.5^{a}	0.7^{b}	$0.8^{a,b}$
C20:5*n*-3	0.4	0.3	0.3
C22:5*n*-3	0.8^{a}	0.4^{b}	0.4^{b}
C22:6*n*-3	0.06^{a}	0.3^{b}	0.4^{b}
CLA*c*9,*t*11	0.3^{a}	0.5^{b}	0.5^{b}
Σ SFA	45.8	46.6	48.7
Σ MUFA	45.5	47.4	44.5
Σ *n*-3 FA	2.1	2.1	1.8
Σ *n*-6 FA	6.1	3.5	4.6
n-6/*n*-3 FA	2.8^{a}	1.6^{b}	2.5^{a}

Table 4: Milk fatty acid composition (%) of cows fed different fat supplements

Fatty acids	SAT LSM	LINA LSM	SUNA LSM
Milk fat (%)	3.8^{a}	2.3^{b}	2.2^{b}
C12:0	3.8^{a}	2.5^{b}	2.3^{b}
C14:0	12.6^{a}	10.7^{b}	9.9^{b}
C16:0	38.0^{a}	25.6^{b}	24.2^{b}
C16:1	1.8	1.7	2.0
C18:0	8.1	9.9	10.0
ΣC18:1*trans*	3.9^{a}	8.9^{a}	12.4^{c}
C18:1*tr*-11	1.5^{a}	4.7^{b}	6.9^{c}
C18:1*cis*-9	19.5^{a}	26.2^{b}	24.9^{b}
C18:2*n*-6	2.0^{a}	2.1^{a}	3.8^{b}
C18:3*n*-3	0.4^{a}	1.2^{b}	0.5^{a}
C20:4*n*-6	0.2^{a}	0.09^{b}	0.09^{b}
C20:5*n*-3	0.03^{a}	0.05^{b}	0.04^{a}
C22:5*n*-3	0.1^{a}	0.09^{a}	0.08^{b}
C22:6*n*-3	0.02^{a}	0.14^{b}	0.15^{b}
CLA*c*9,*t*11	0.01^{a}	0.04^{b}	0.07^{c}
Σ SFA	67.9^{a}	52.5^{b}	50.0^{b}
Σ MUFA	28.5^{a}	42.5^{b}	44.5^{b}
Σ *n*-3 FA	0.7^{a}	1.6^{b}	0.9^{a}
Σ *n*-6 FA	2.4^{a}	2.3^{a}	4.0^{b}
n-6/*n*-3 FA	3.6^{a}	1.5^{b}	4.6^{c}

(a,b – denote significant differences between groups at P ≤ 0.05)

Table 1: Meat quality

	SAT LSM_{SE}	LINA LSM_{SE}	SUNA LSM_{SE}
pH_{24h}	$5.6_{0.03}$	$5.6_{0.03}$	$5.6_{0.03}$
Colour L*	$29.2_{1.0}$	$27.5_{1.0}$	$29.8_{1.0}$
Protein (%)	$21.9_{0.3}$	$21.6_{0.3}$	$21.8_{0.3}$
Fat (%)	$3.0_{0.8}$	$4.1_{0.8}$	$3.6_{0.8}$
Ash (%)	$1.0_{0.02}$	$1.0_{0.02}$	$1.0_{0.02}$
Shear force (kg/cm^2) after 14 d storage	$6.7_{0.6}$	$6.7_{0.6}$	$5.1_{0.6}$

Table 2 : Performance and milk composition

	SAT LSM_{SE}	LINA LSM_{SE}	SUNA LSM_{SE}
Live weight at slaughter (kg)	575.8_{25}	570.7_{25}	612.5_{25}
DM offer (kg/cow/d)	21.2	21.2	21.2
Milk yield (kg/d) Ø 10 weeks	$29.9_{1.6}$	$32.5_{1.6}$	$34.7_{1.6}$
Lactose (%) Ø 10 weeks	$4.8_{0.05}^{a}$	$5.0_{0.05}^{b}$	$4.9_{0.05}$
Milk fat (%) Ø 10 weeks	$3.8_{0.1}^{a}$	$2.3_{0.1}^{b}$	$2.2_{0.1}^{b}$
Milk protein (%) Ø 10 weeks	$3.3_{0.1}$	$3.1_{0.1}$	$3.1_{0.1}$

CONCLUSION

The study indicates improvements of meat and milk lipid profiles upon dietary fatty acid supplementation without substantially affecting meat quality traits. Effects were tissue-specific different.

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